

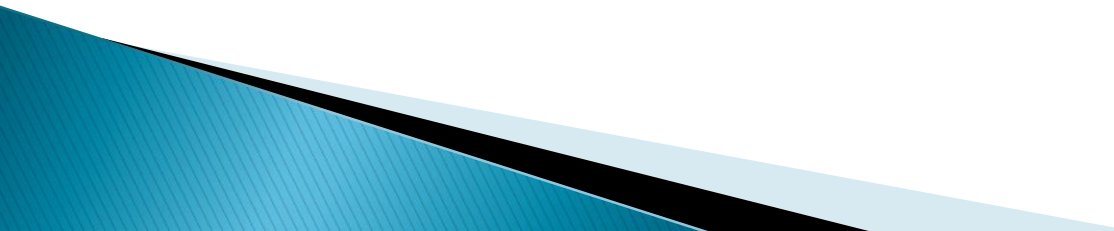
WEST VIRGINIA SUPER CIRCUIT (WVSC)

International Microgrid Symposium,
San Diego, CA
17–18 September, 2009

Hakan INAN

Science Applications International Corporation (SAIC)

Outline

- ▶ WVSC Project Overview
 - ▶ Project Objectives
 - ▶ Morgantown Developmental Field Test
 - ▶ WVSC Project Technologies
 - ▶ Technical Challenges
 - ▶ Project Benefits
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WVSC Project Overview

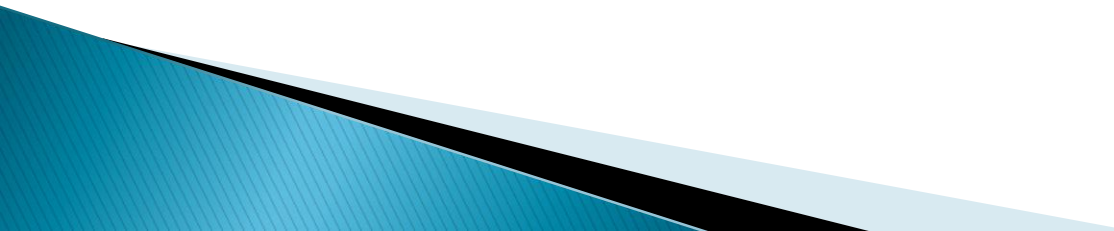
▶ Team Members

- Allegheny Power – PM
- Science Applications International Corporation (SAIC) – Systems integrator, design, testing
- West Virginia University (WVU) Research Park – Distributed generation
- WVU Advanced Power and Electricity Research Center – Agent based controls development, modeling & simulation,
- North Carolina State University – Fault location, fault prediction
- Augusta Systems, Inc. – Communications network
- Tollgrade Communications – Advanced sensors

▶ Current Status

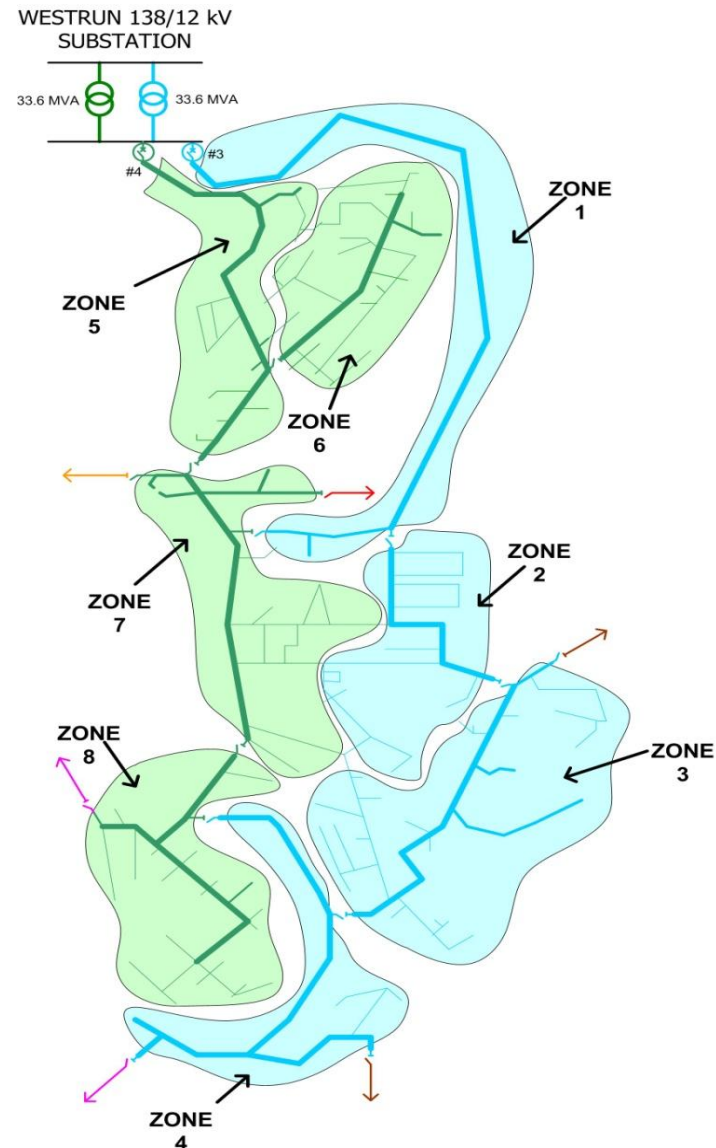
- Negotiations between NETL/Allegheny Power. Expected project kick-off October, 2009

Project Objectives

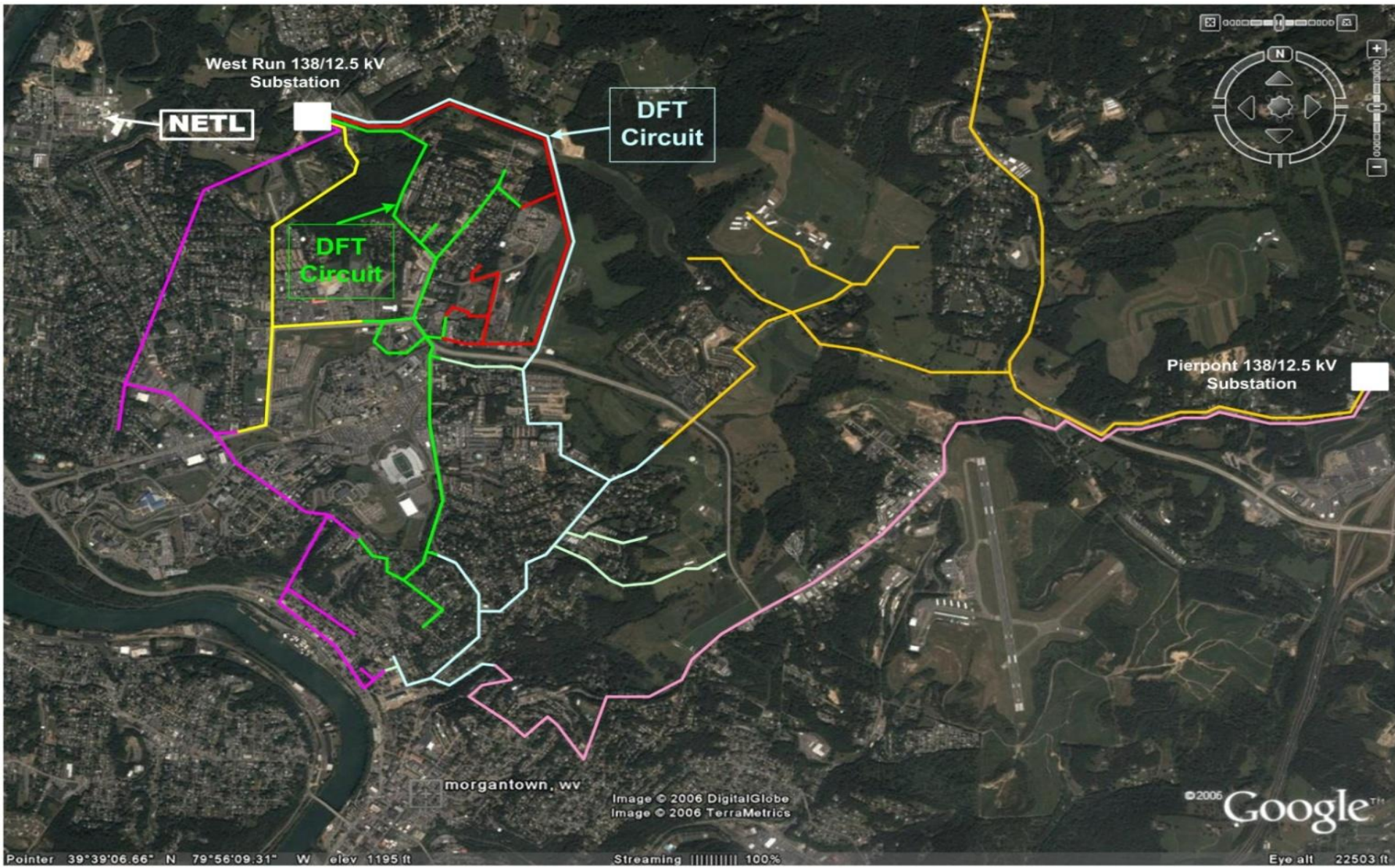
- Achieve $\geq 15\%$ peak power reduction; demonstrate that this can be done at a cost competitive with capacity upgrades
 - Demonstrate the viability of advanced circuit control through multi-agent technologies
 - Demonstrate the benefits of the integrated operation of rotary and inverter-based distributed generation (DG), energy storage, Automated Load Control (ALC), advanced wireless communications, and advanced system control technologies
 - Use advanced operational strategies such as dynamic islanding and micro-grids to serve priority loads through the integration of ALC with advanced system control
 - Demonstrate the reliability benefits of Dynamic Feeder Reconfiguration (DFR) across two adjacent feeders
 - Leverage advanced wireless communications to address interoperability issues between control and protection systems and distributed energy resources (DERs)
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Morgantown Developmental Field Test (DFT)

- ❑ Cost-shared demonstration project between DOE/NETL and Allegheny Power
- ❑ Goal: Major improvement in reliability, minimize labor cost associated with fault restoration
- ❑ Scope: Dynamic Feeder Reconfiguration System
 - ❑ Locate & isolate the feeder fault, restore service from adjacent feeders
 - ❑ 5,000 customers, two 138/12.5 kV substations, 668 distribution transformers, 29 MVA of installed capacity in two circuits
- ❑ Real-time monitoring of distribution circuits, remote control of automated switchgear
- ❑ Wi-Fi mesh communications network
- ❑ Site Acceptance Test completed in August, 2009
- ❑ West Virginia Super Circuit will build on one of the two DFT circuits

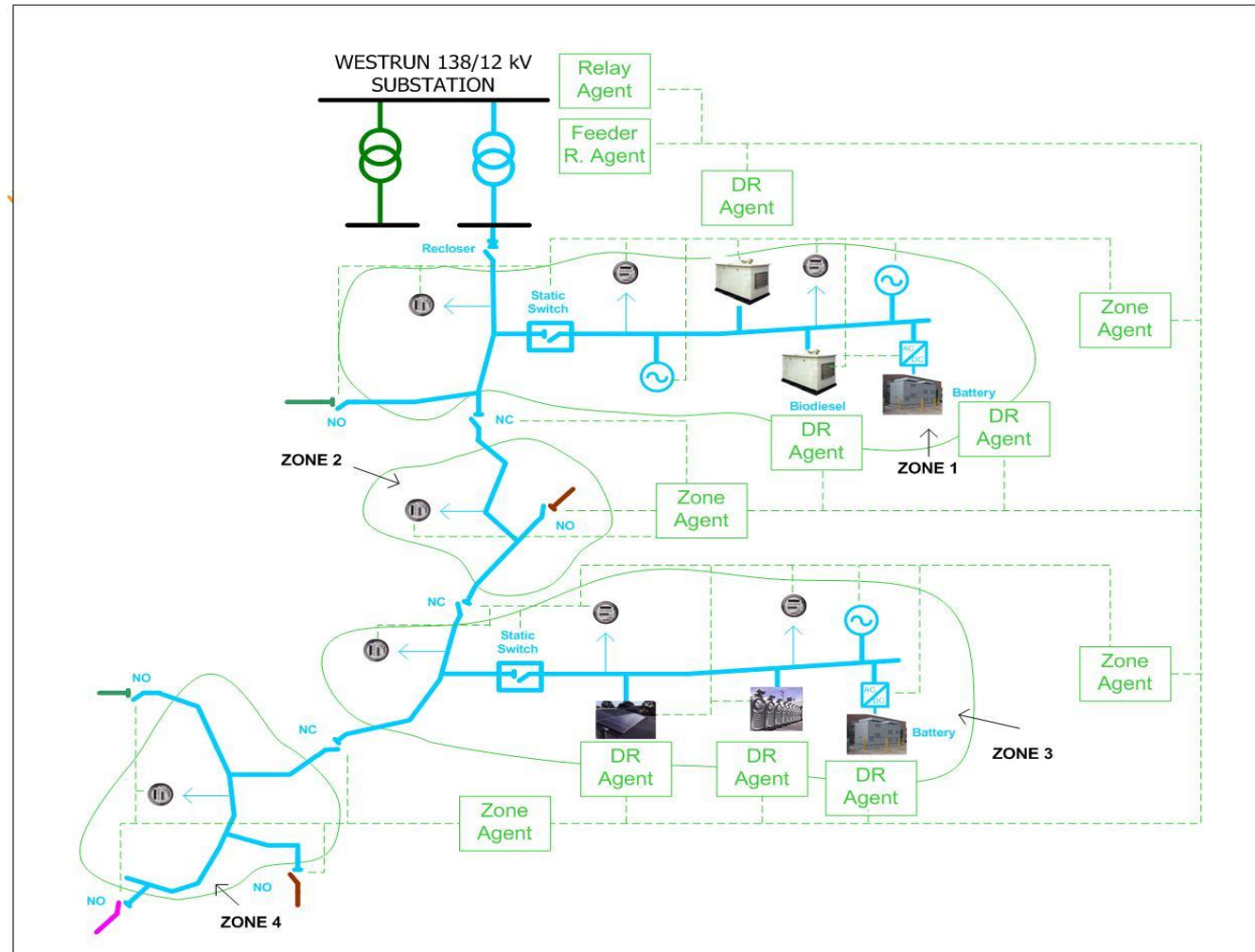


WVSC Demonstration Site



Project Technologies

- **Distributed Energy Resources**
- ❖ 1.2 MW (3x400 kW) Biodiesel Internal Combustion Engines (ICE)
- ❖ 250 kW Micro-turbine
- ❖ 100 kW Solar Photovoltaic (PV) System
- ❖ 500 kW (2x250 kW), 8 hrs Energy Storage



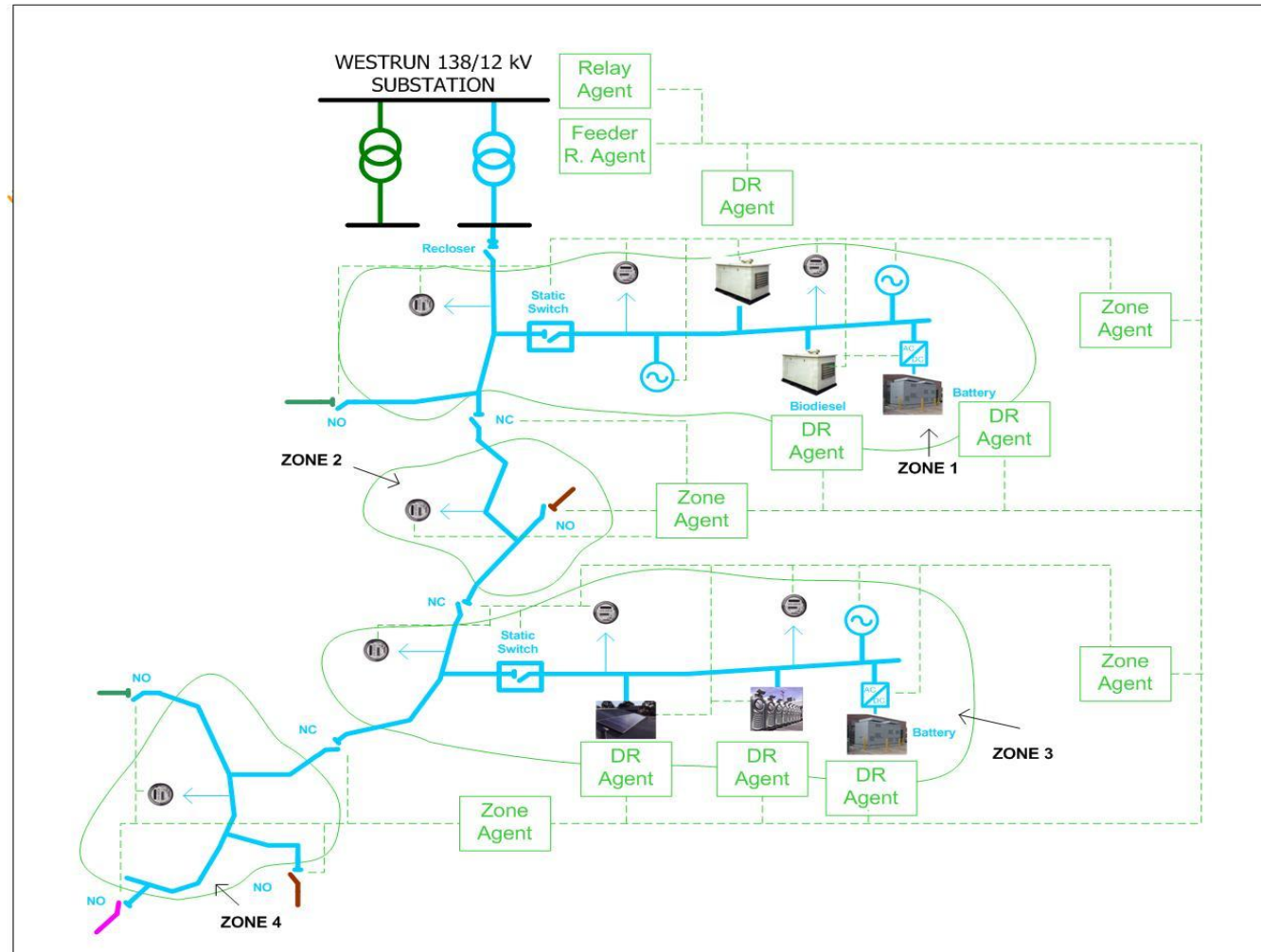
Project Technologies

Multi-Agent Management System (MGM)

- West Virginia University/APERC will develop the algorithms for Multi-Agent Grid Management Systems.
- Autonomous controls
- The integrated operation of distributed resources, ALC and other intelligent electronic devices

Demand Response and Automated Load Control

- DR/ALC will be deployed to participating customers on the WR-3 circuit.
- The system will allow AP to control customer loads (A/C, water heater, etc) via advanced system automation



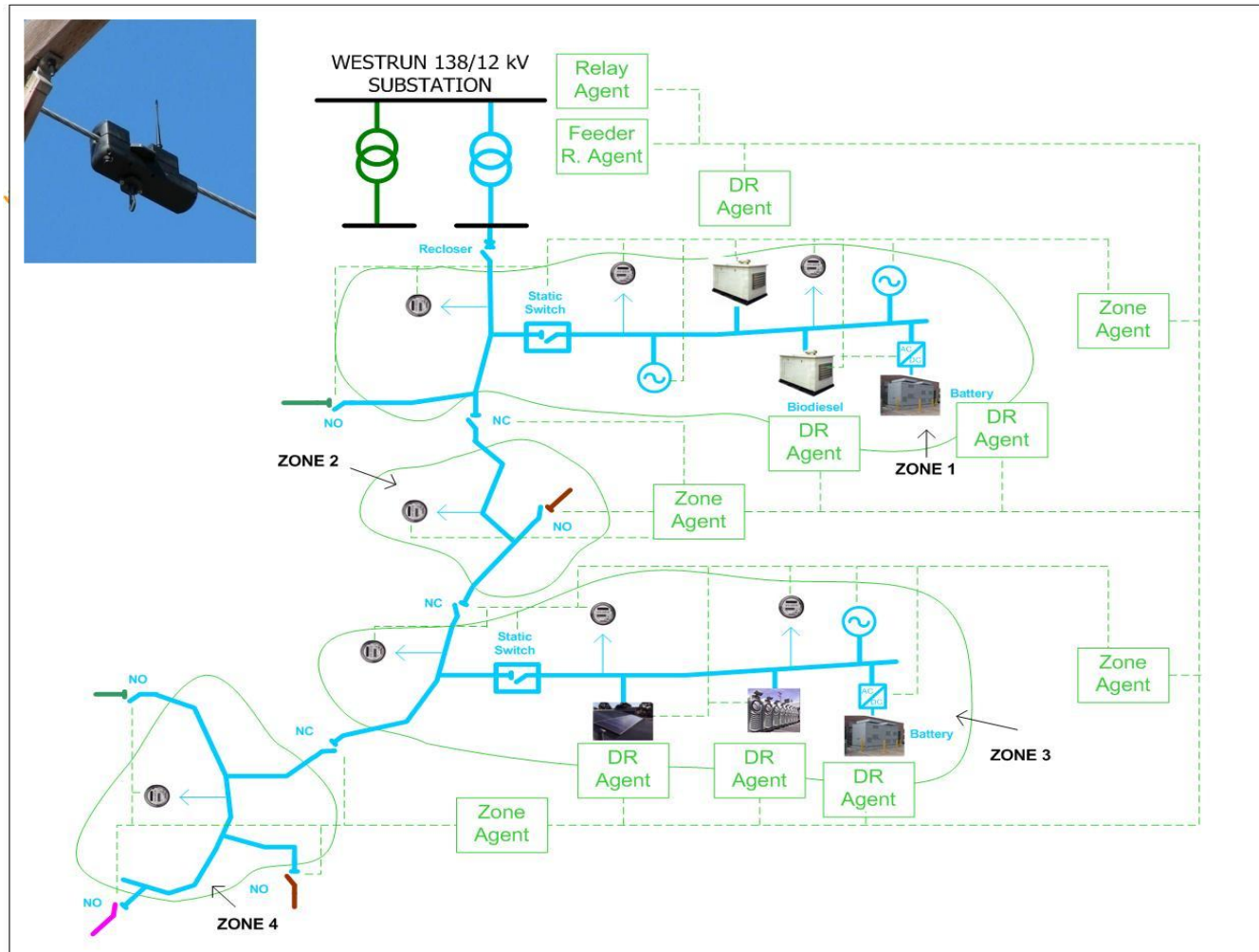
Project Technologies

▶ Low-Cost Distribution Sensors

- Nominal current,
- Surge and fault current,
- Relative voltage,
- Wire temperature
- Clamps to medium voltage lines via a standard hot stick
- Inductively coupled

▶ Fault Location & Prediction

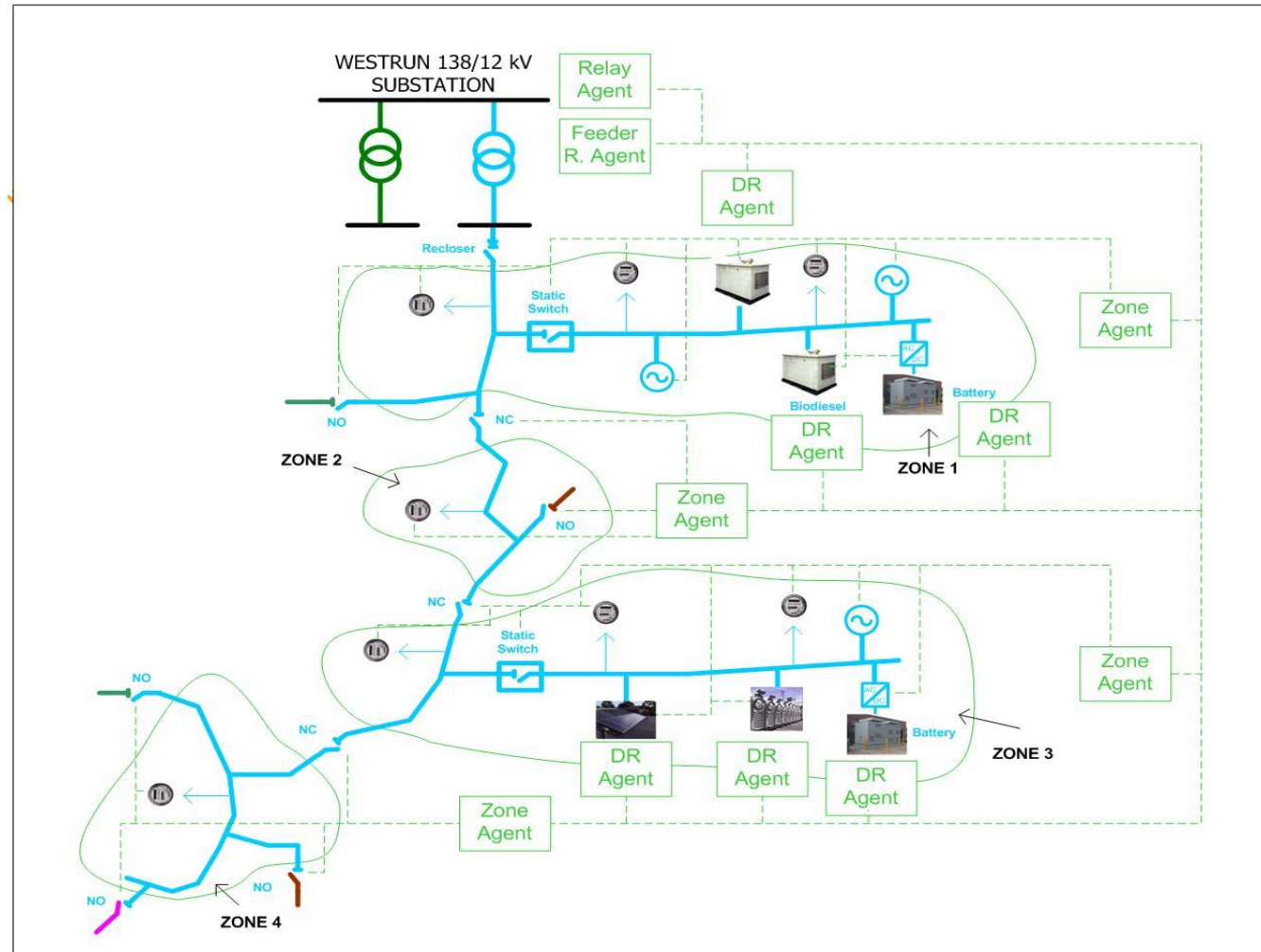
- North Carolina State University will develop the algorithms
- Analyze voltage and current signatures of many typical circuit disturbances that are intermittent in nature
- Identify circuit components that are beginning to fail
- Determine exact location of the disturbance



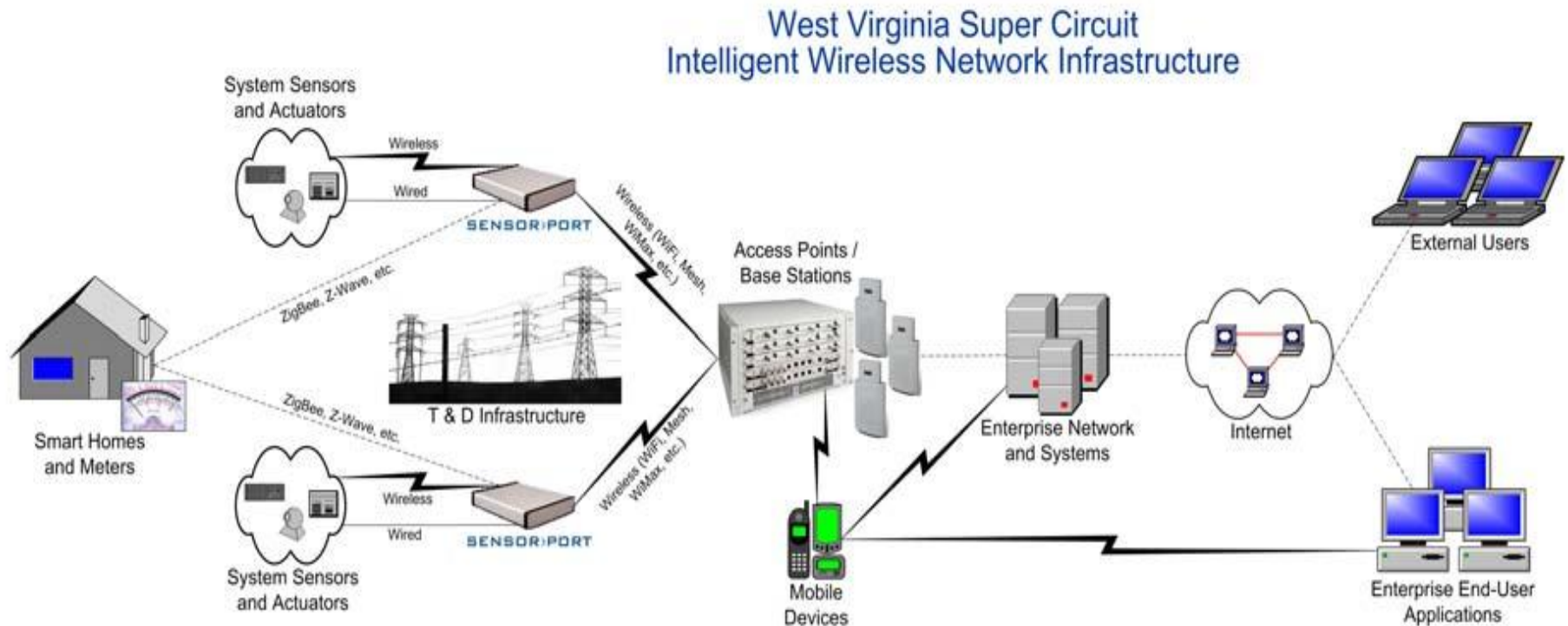
Project Technologies

► Dynamic Feeder Reconfiguration

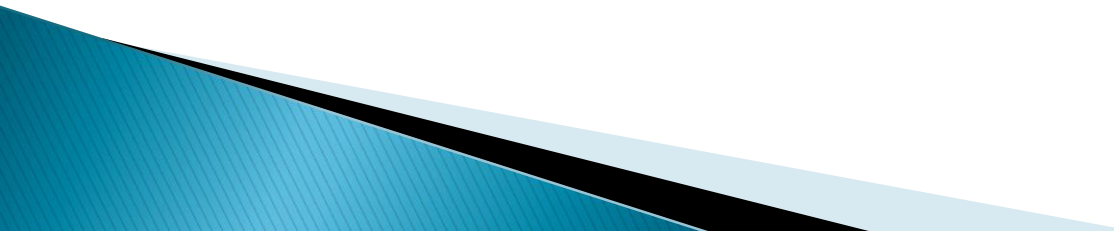
- Expand the DFR system to 2 additional feeders (WR-5/WR-8)



Project Technologies



Technical Challenges

- ▶ **Microgrid Operation Challenges**
 - Seamless transition
 - Stability issues
 - ▶ **Optimal Placement and Sizing of DERs**
 - Loss minimization
 - Recloser–fuse coordination
 - ▶ **Protective System Challenges**
 - Bi–directional currents
 - Limited fault current magnitudes due to Power–Electronics
 - ▶ **Interoperability**
 - ▶ **Cyber Security**
 - ▶ **Wireless Communication Network Challenges**
 - ▶ **Personnel Safety**
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Project Benefits

Metric	Multi-Agent Grid Management (MGM)	Dynamic Feeder Reconfiguration (DFR)	Demand Response (DR) & Automated Load Control (ALC)	Fault Location & Prediction (FLP)	Total
Peak Load Reduction	20%		10%		30%
Deferment of Capital Investment	600K		200K		
CAIDI	20%	20%	5%	5%	50%
SAIFI	20%	20%	5%	5%	50%
Loss Reduction	30%				
Labor savings (assoc. w/fault location)		75%		15%	90%
PQ event reduction	30%				30%
Capacity utilization of DER	50%				50%
Capacity utilization of feeder	25%				25%
NOx-Sox emissions reduction	10%		5%		10%

► Thank you!